



***IMEC EDM Forum: 3D Printing Technology for
advanced processor cooling
May 18th, 2021***

Materialise Design & Engineering services



Agenda

1. About Materialise
2. Materials & Production techniques
3. Metal printing principles
4. Design for SLM
5. Heatsink designs
6. Questions

1. About Materialise

Materialise at a glance – key figures



With more than 30 years of building knowhow in the field of Additive Manufacturing, Materialise has positioned itself as a seasoned pioneer in the field of Additive Manufacturing. Backed up by a wide range of leading technologies, more than 170 machines and a wide variety of materials going from polymers to metals, the solutions offered are linked to the specific requirements of particular industries and applications. In order to adhere to the quality standards in highly demanding industries, such as healthcare and aeronautics, certified manufacturing lines have been established utilizing cutting edge technology to enable quality control on dimensional stability, accuracy and surface quality. In addition, software controlled manufacturing processes allow us to trace material quality and process parameters in extraordinary detail and store the data for periods up to 80 years.

Constantly growing our 3D
printing expertise

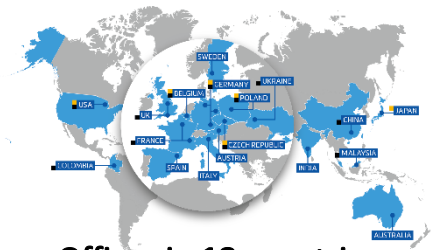
Speaking your language

Passionate about innovation

Wide variety of technologies
and materials



+ 175 3D Printers



Offices in 18 countries



+245 patents granted

+180 patents pending



+30 Materials

+90 color and finishing options

Materialise at a glance – 4 key business units

Materialise Mindware

Advisory services for business success with AM



Materialise Software

Leading software to manage & control the entire AM process

- 92% Of the largest metal AM system manufactures
- 85% Of all automotive companies of the Fortune Global 500
- 40% Of the top 20 companies of the Fortune Global 500



Materialise Manufacturing

Europe's Largest & Most complete Factory for 3D Printing

- +175 3D printers
- +30 Materials
- +90 Finishes



Materialise Medical

Services that revolutionize patient-specific treatment

- +40K Patients helped yearly
- +350K Patient-specific models, guides and implants created
- +5M Patient scans analyzed with our medical software

Materialise Expertises (1/5)

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Strong track record in creating meaningful product innovations

With more than 100+ co-creations successfully executed annually, Materialise has positioned itself as the trusted partner for renowned product brands across numerous industries to help turn conceptual ideas into meaningful end use products by exploiting AM to its highest potential. Additive Manufacturing of end use parts is complex and dependent on requirements of the application domain. Exploiting opportunities requires deep knowledge and expertise in process engineering, materials, design and engineering for AM and software tools to ensure quality and consistency. **Our competence centers bring together experts from different disciplines to work in close proximity and in concert on concepts and products.**



HOYA's Vision Simulator & EyeGenius:
3D-Printed Eyecare Devices



NewBorn Heart Rate Sensor: 3D
Printing to Reduce Infant Mortality



Sound Advice for Redesigning a Small
Series Brain Scanner

Materialise Expertises (2/5)

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Design for AM in everything we do

Additive Manufacturing offers you immense design freedom, but using it requires understanding the interplay between production technology, material and the intended application of your design. Partner up with our design & engineering team and count on their unbiased advice to add to your development project.

Exploration

- Analyze/Fix input data
- Feasibility Check
- Workshop/Training

Concept Development

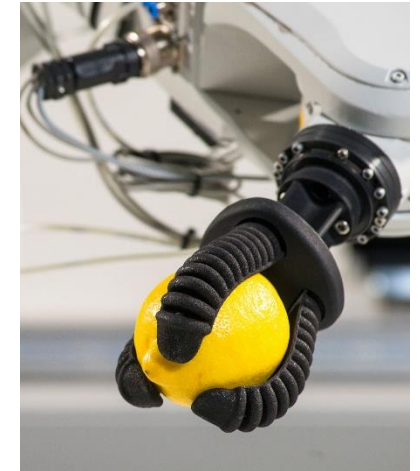
- Ideation
- Visualization
- Procedural modeling

Detailed Design

- Digital texturing
- Lattice structures
- ...

Launch Preparation

- Design for traceability
- Post-processing optimization
- Design for assembly



Materialise Expertises (3/5)



European leader in Certified Manufacturing Solutions

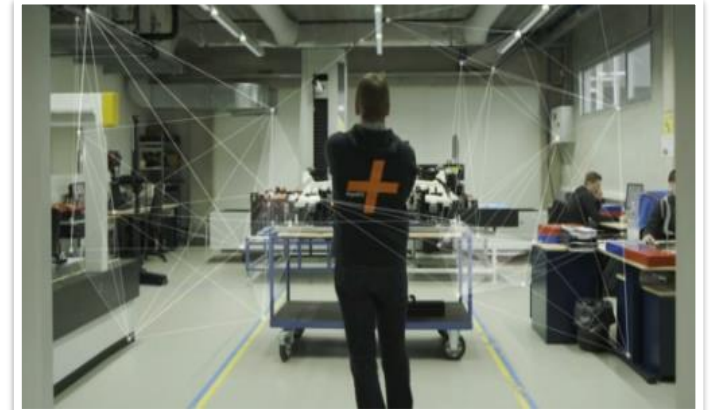
Materialise positions itself as a solution provider in the AM Value chain. In Europe, Materialise is the leading provider of sophisticated Additive Manufacturing services. With a capacity of more than 180 printers, it offers the most advanced and complete range of technologies and materials, both in metals and plastics. In order to adhere to the quality standards in highly demanding industries, such as healthcare and aeronautics, certified manufacturing lines have been established that utilize cutting edge technology to enable quality control on dimensional stability, accuracy and surface quality. In addition, software controlled manufacturing processes allow us to trace material quality and process parameters in extraordinary detail and store the data for periods up to 80 years.



Dedicated Medical Production
ISO 13485 Certification



Dedicated Aerospace Production
EASA Part 21G and EN9100 certification



**Dedicated Factory for Customised Jigs, Fixtures
and Quality Control Solutions** ISO9001
certification

Materialise Expertises (4/5)

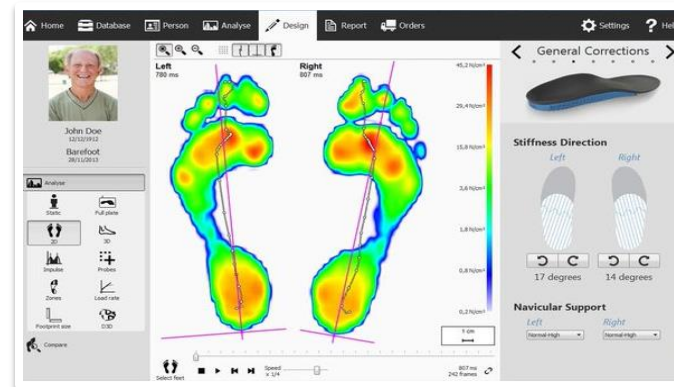
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End-to-End Solutions Enabling Digital Supply Chains

Digitisation has stirred a new wave of innovation. Driven by this evolution, game-changing businesses and industries explore new opportunities to enable fully personalised experiences and products. Materialise Software is at the core of this drive. Materialise offers the software backbone to develop fully customised solutions for digital imaging, design automation tools, file preparation, order management systems and software, to support digital production according to the quality standards of your industry. Over the past 25 years we have co-created platforms that function as the engine of disruptive innovations in the medical industry, industrial automation, hearing aids, footwear and eyewear sectors. **Our end-to-end solutions have truly enhanced interaction mechanisms between customers and professionals, enabling novel experiences and innovation in product development.**



Hoya - Yuniku Platform
Fully Customized Eyewear



RS Print Platform
Fully Customised Insoles



Phonak - Rapid Shell Modelling
For Hearing Aid's

Materialise Expertises (5/5)

Long track record in the automotive industry

The automotive industry continuously requires faster and more cost-effective development and production. Traditional ways of working no longer do the trick if you want to stay ahead of the curve. At Materialise, we apply innovative technology to take you from concept to car in the highest gear. With a long history from automotive prototyping to pioneering in producing automotive end-parts, Materialise got the knowhow to spot, develop and produce products to your needs.



Concepts and prototypes for form, fit and function testing

From the smallest interior component to life-size body parts.



End-use parts

Whether you're looking at mass customization for interior parts or lightweight structural components, we are there to deliver end parts that provide you with a competitive edge.

3D Printing from Concept to Car

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Concept development

Product Design

Manufacturing
Engineering

Industrialization



materialise
manufacturing

Metal & Plastic Prototypes

Customized End-parts

Concept and Scale Models



ACTech
a materialise company

Cast metal Prototypes



RapidFit+
a materialise company

Production Tools (jigs, assembly aids, ...)

Quality Inspection Tools (checking & measuring fixtures, calibers, ...)

Cubing fixtures

2. Materials & Production techniques

Common production techniques & materials

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Laser Sintering

Laser Sintering, also known as selective Laser Sintering (SLS), is among the most versatile and frequently used 3D printing technologies: you can find laser-sintered parts in airplanes, wearables, machine components and production tools.

Common Applications

- ✓ Manufacturing series of small components
- ✓ Prototyping for functional or form-and-fit testing
- ✓ Producing unique, complex, designs as one-off products

[AVAILABLE MATERIALS >](#)



Stereolithography

Stereolithography, also known as SLA or SL for short, is the veteran of 3D printing technologies. It's been around at Materialise since 1990 and continues to be one of the most widely used rapid prototyping technologies in plastics.

Common Applications

- ✓ Visual prototypes and "show-and-tell" parts
- ✓ Masters for copying techniques like Vacuum Casting
- ✓ Complex, esthetic art objects

[AVAILABLE MATERIALS >](#)



Metal 3D Printing

Metal 3D Printing holds a unique position in modern-day product development. It allows for the direct manufacturing of complex end-use parts and facilitates tooling for conventional manufacturing technologies, reducing costs and lead times.

Common Applications

- ✓ Production tools, molds, and inserts
- ✓ Housings, ductwork, and spare parts
- ✓ Fully functional prototypes

[AVAILABLE MATERIALS >](#)

Common production techniques & materials

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Multi Jet Fusion

HP spread waves of excitement throughout the 3D printing world with the announcement of the Multi Jet Fusion (MJF) technology. Discover the new technology that is ideal for when you need short lead times, low porosity and excellent surface quality, for functional prototypes and small series.

Common Applications

- ✓ Low-volume production of complex end-use parts
- ✓ Prototyping for functional or form-and-fit testing
- ✓ Producing series of small components

[AVAILABLE MATERIALS >](#)



Fused Deposition Modeling (FDM)

FDM can build just about any geometry you have in mind. That's why you can find FDM parts as end-use components in airplanes, as production tools in an automotive factory, and as prototypes just about anywhere.

Common Applications

- ✓ Low-volume production of end-use parts
- ✓ Prototypes for form, fit and function testing
- ✓ Prototypes directly constructed in production materials

[AVAILABLE MATERIALS >](#)



PolyJet

PolyJet offers the unique ability to print parts of multiple materials and colors, with different mechanical or physical properties, all in a single build. So you can confidently order parts of unparalleled complexity with a high-quality finish.

Common Applications

- ✓ Visual models with fine details and smooth surfaces
- ✓ Parts to match specific Shore A values and colors
- ✓ Masters for copying techniques like Vacuum Casting

[AVAILABLE MATERIALS >](#)

3. SLM principles

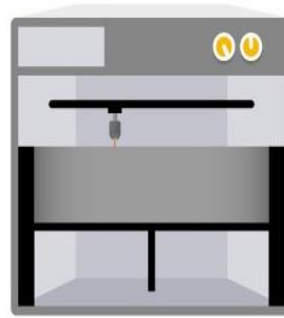
Metal 3D Printing:



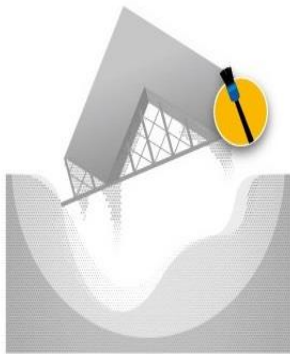
The 3D model



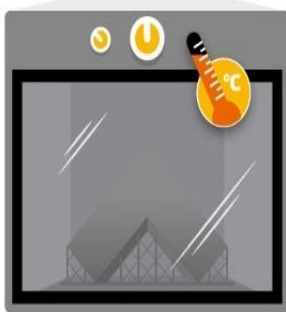
A laser melts metal particles together



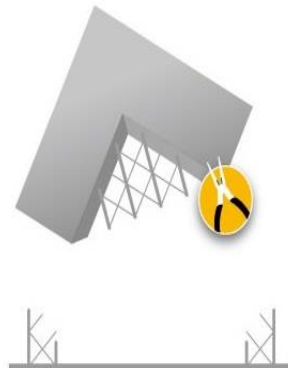
Successive layers of metal powder are spread on top, while a laser selectively binds particles to form the part and its support



The loose powder is removed



The part undergoes heat treatment



The support is removed



The part is finished

Standard lead time

Minimum of 10 working days
(depending on part size, number of components and required finishing)

Standard accuracy

+/- 0.2% (with lower limit on ± 0.2 mm)

Minimum wall thickness

0,5 mm

Layer thickness

0.03 mm – 0,1 mm

Maximum part dimensions

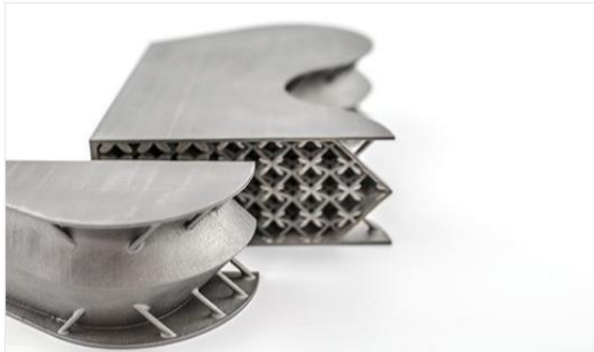
500 x 280 x 345 mm

SLM materials



Aluminum (AlSi₁₀Mg)

- › Good strength and thermal properties with low weight
- › Flexible post-processing possibilities
- › Lead time: 10 working days
- › Maximum part dimensions: 500 x 280 x 315 mm



Titanium (Ti₆Al₄V)

- › Excellent mechanical properties with very low specific weight
- › Corrosion-resistant
- › Lead time: 10 working days
- › Maximum part dimensions: 245 x 245 x 270 mm



Stainless Steel (SS316L)

- › Excellent strength, high ductility & good thermal properties
- › Highly corrosion-resistant
- › Lead time: 10 working days
- › Maximum part dimensions: 250 x 250 x 280 mm



Inconel (IN718)

- › Exceptional thermal resistance up to 700°C
- › High yield, tensile and creep-rupture properties
- › Long-duration strength at extreme temperatures
- › Lead time: 10 working days
- › Maximum part dimensions: 250 x 250 x 295 mm

4. Design for metal AM

M3DP Manufacturing Restrictions

Freedom of Design

Stress
Lines

Support
structures

Powder
removal

Thin walls

Bores and
cylinders

Gaps

Max.
dimensions

Accuracy

Corrosion
resistance

Material
properties

Finishing



Stress Lines

- Layerwise welding process
- Thermally induced stresses due to shrinkage
- Stresses can lead to support failure in the buildup process
- In worst case, part fails
 - Brush re-coater is less sensitive than knife re-coater

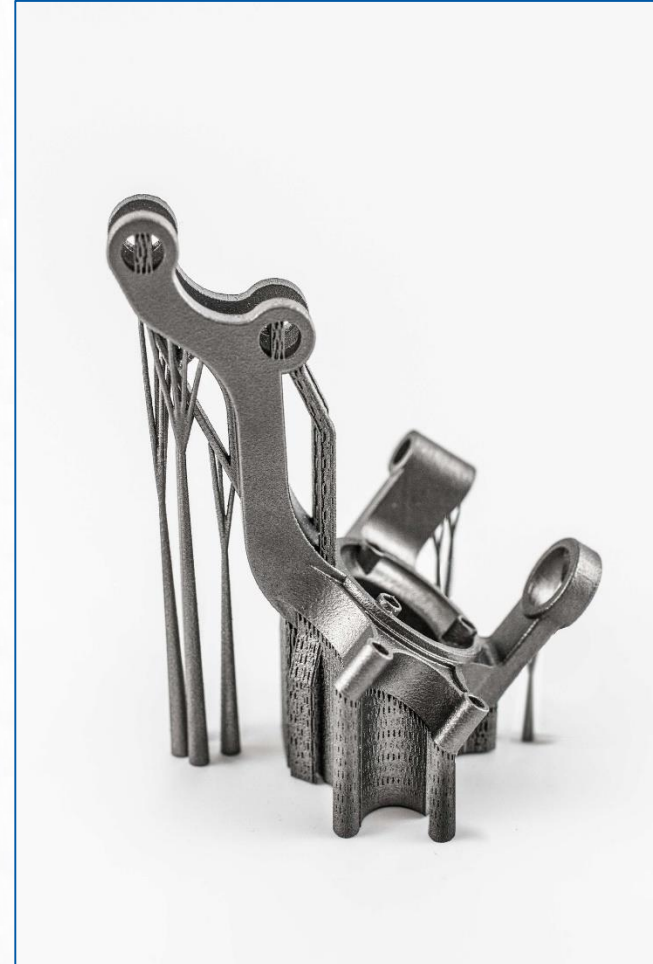


M3DP Manufacturing Restrictions

Support structures

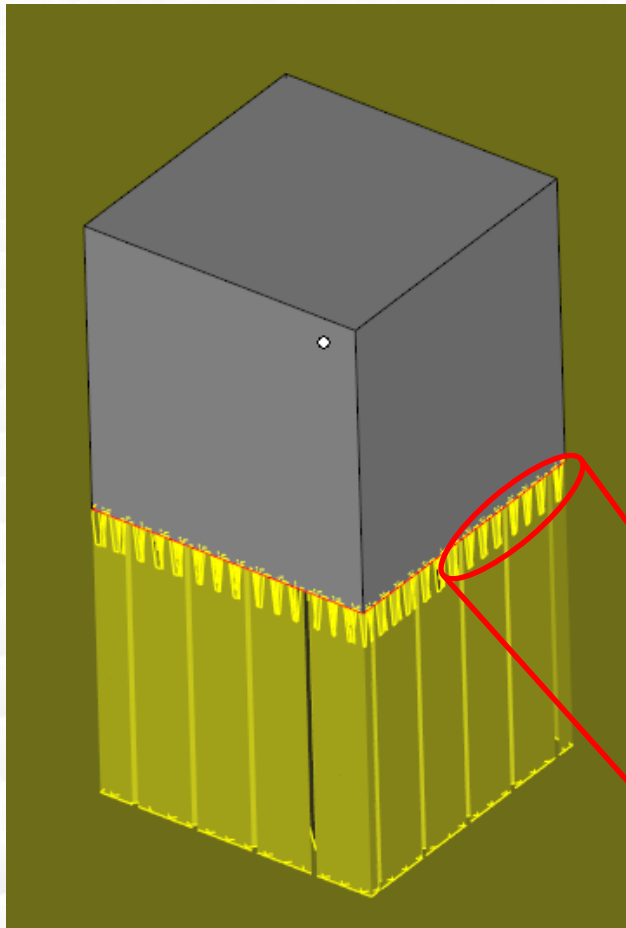
Needed for:

- Absorption of thermally induced stresses
- Optimization of heat flux
- Support of exposed layers



M3DP Manufacturing Restrictions

Support structures

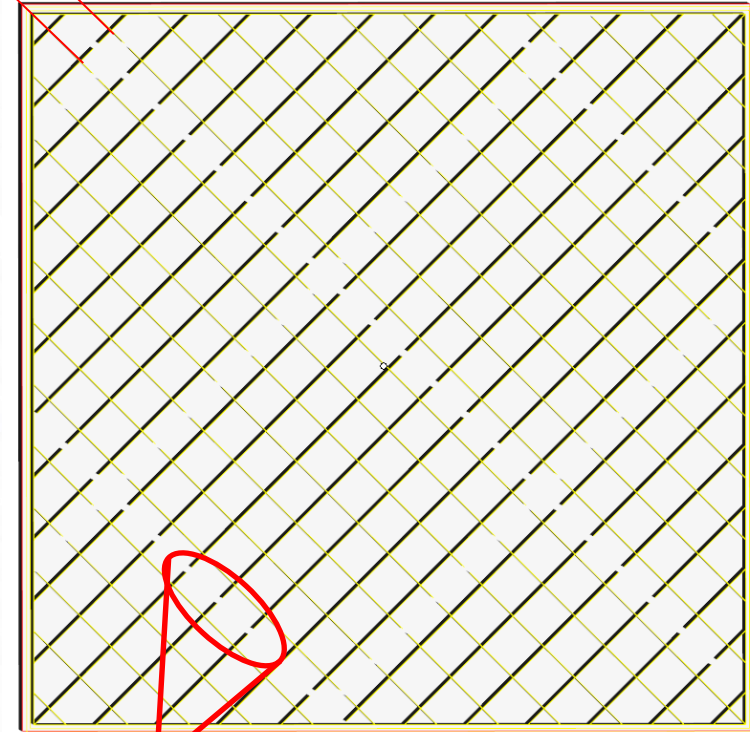


Block support (as example)



Teeth

Hatch distance



Fragmentation

M3DP Manufacturing Restrictions

Support structures

Needed at:

Overhangs

	Overhang*	Horizontal bore L=10mm
AlSi10Mg	< 43°	D > 8mm
316L	< 45°	D > 6mm
TiAl6V4	< 43°	D > 4mm
Inconel 718	< 50°	D > 4mm

**values are depending on part geometrie and orientation*

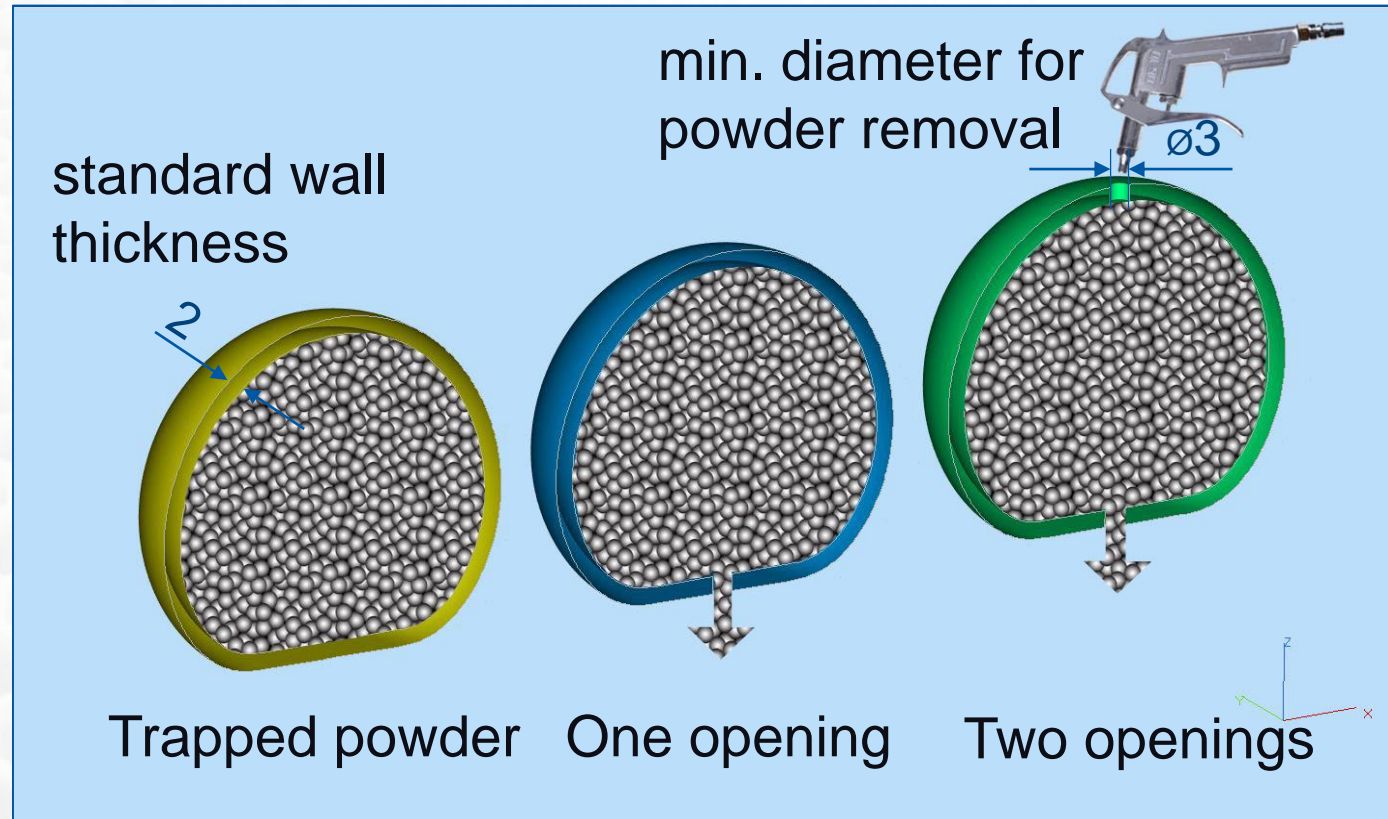
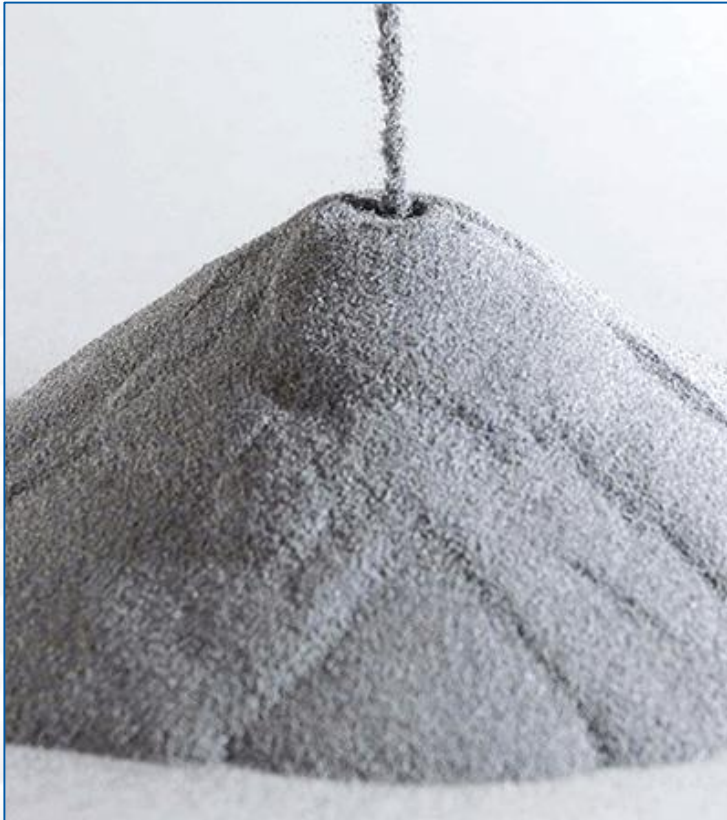


M3DP Manufacturing Restrictions

Powder Removal

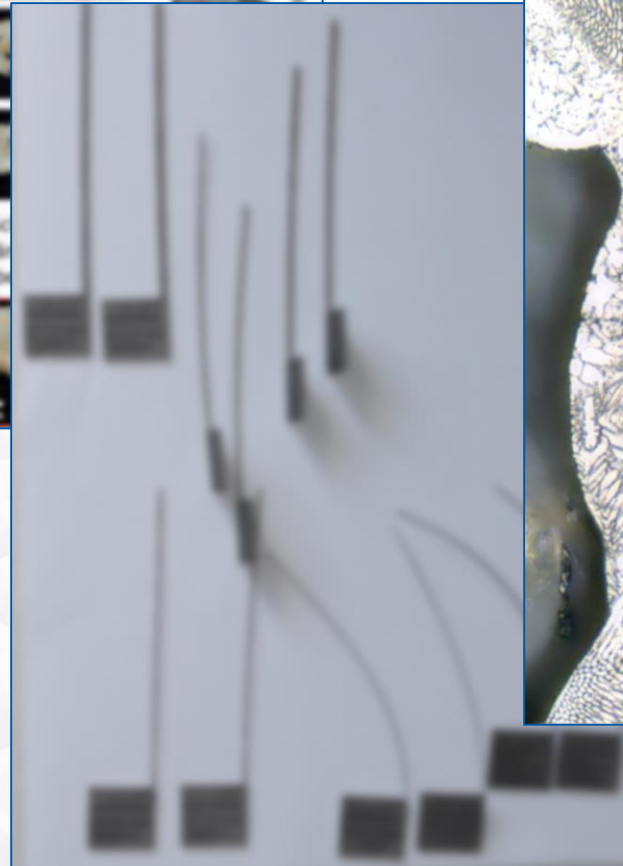
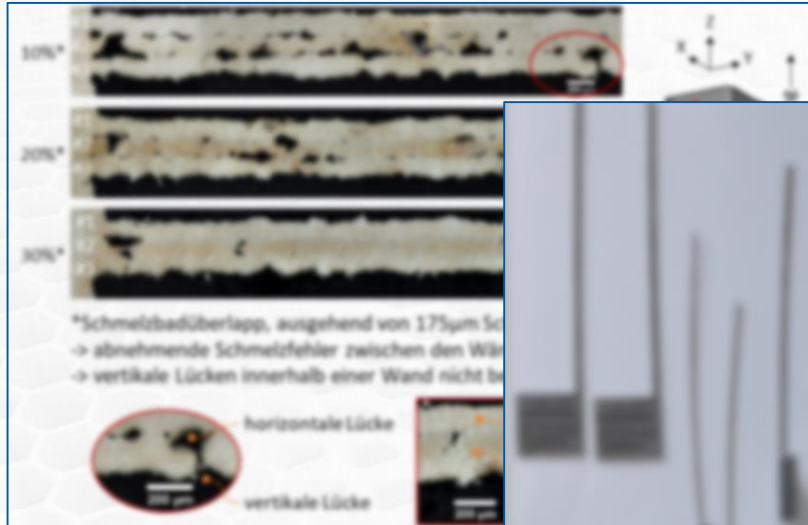


AlSi10Mg powder in contact with water reacts to H₂ (hydrogen) and is explosive



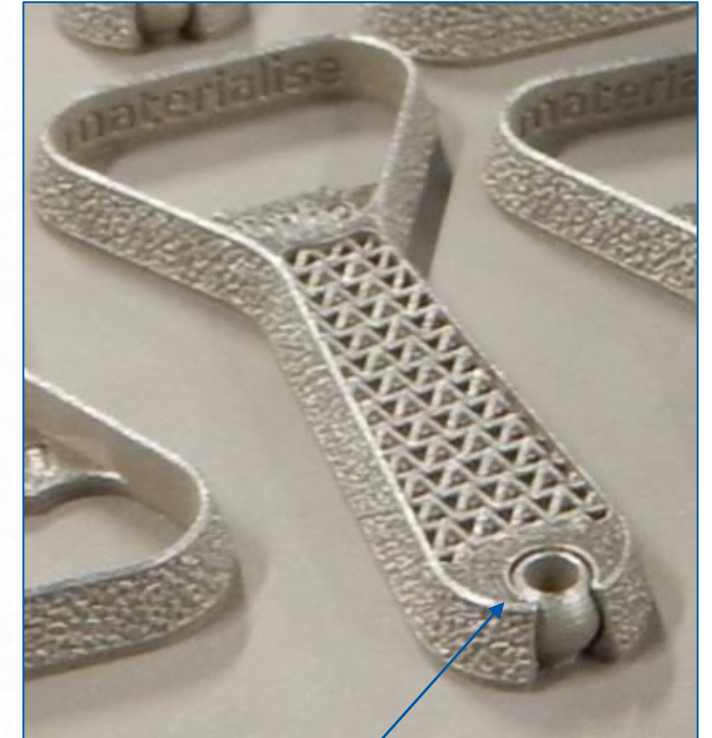
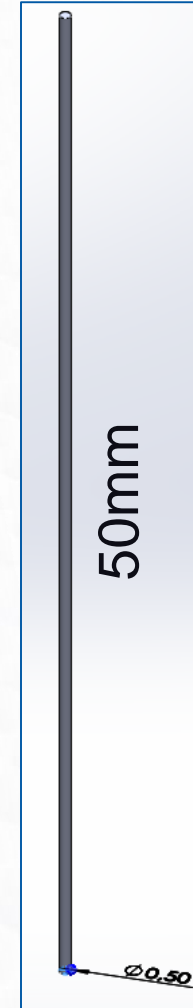
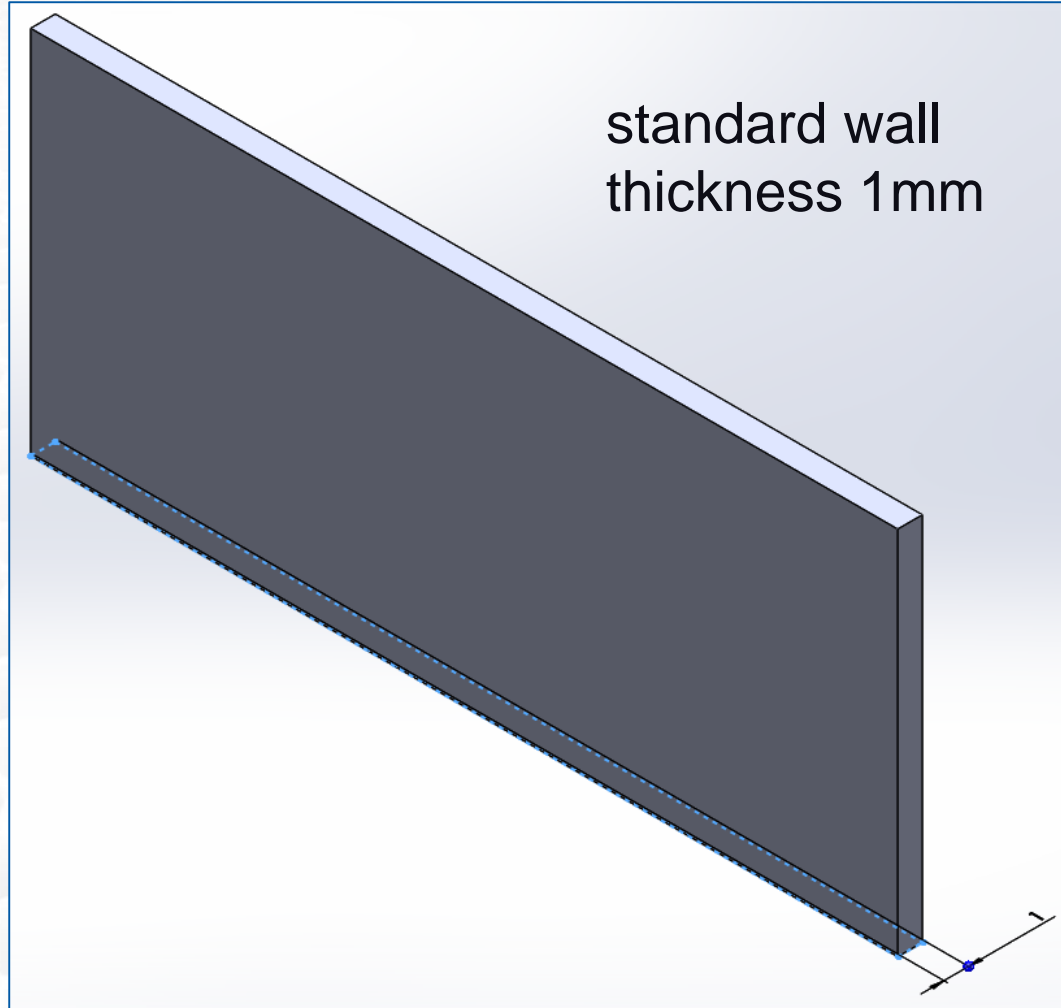
M3DP Manufacturing Restrictions

Thin Walls / Bores and Cylinders / Gaps



M3DP Manufacturing Restrictions

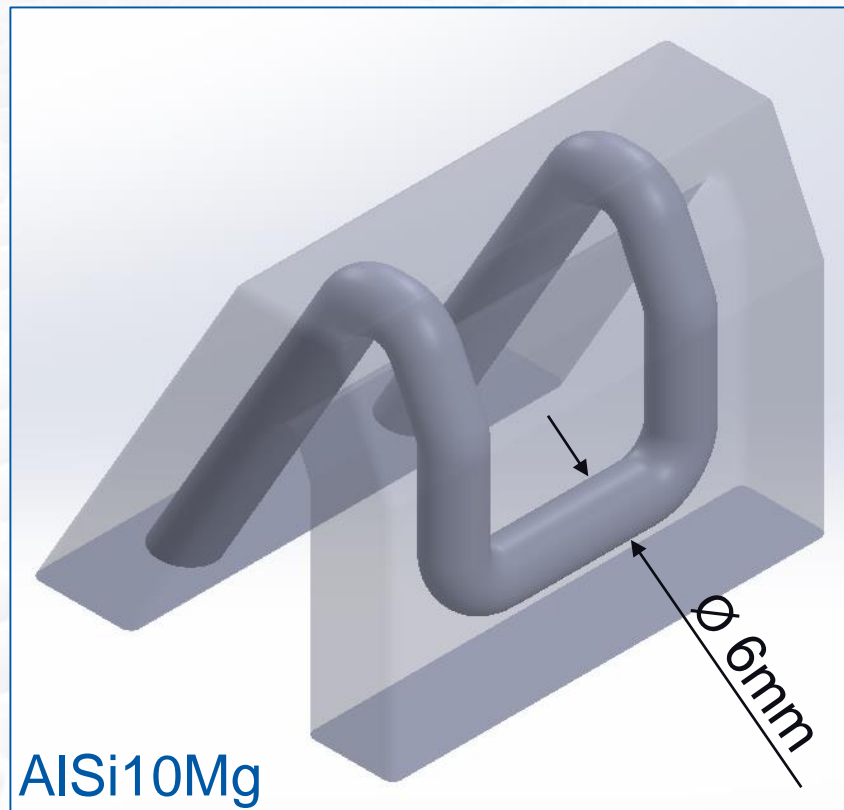
Thin Walls / Bores and Cylinders / Gaps



M3DP Manufacturing Restrictions

Thin Walls / Bores and Cylinders / Gaps

Internal channels



Needed at:

Overhangs

	Supportless overhang*	Horizontal bore L=10mm
AlSi10Mg	43°	D < 8mm
316L	45°	D < 6mm
TiAl6V4	43°	D < 4mm
Inconel 718	50°	D < 4mm

*values are depending on part geometrie and orientation

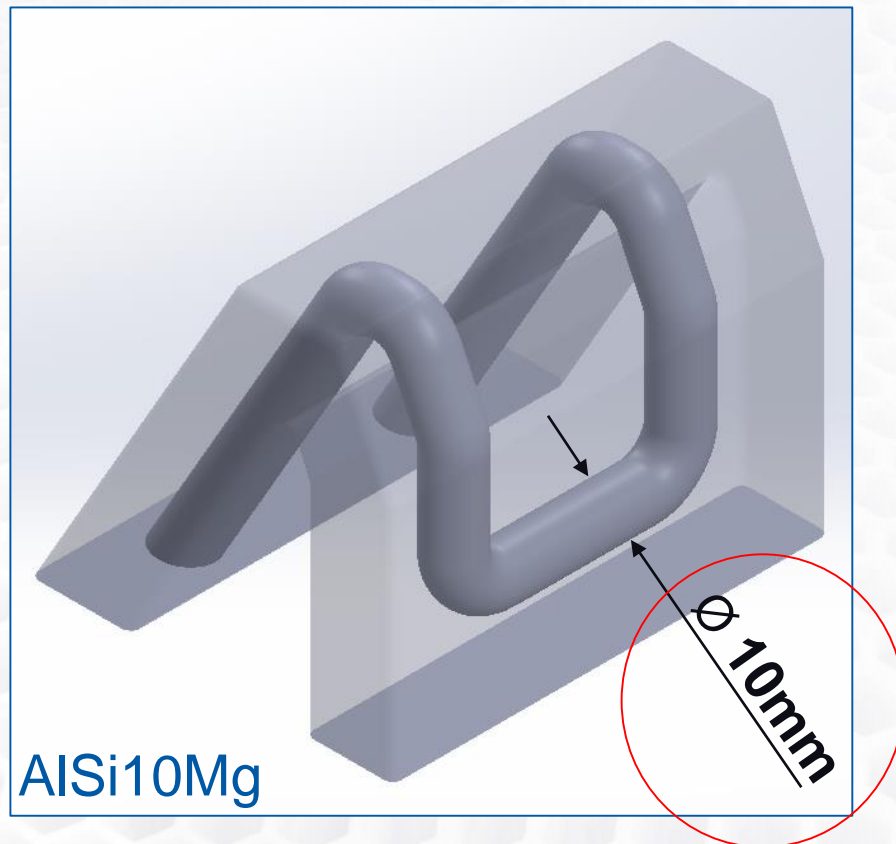
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M3DP Manufacturing Restrictions

Thin Walls / Bores and Cylinders / Gaps

Internal channels



Needed at:

Overhangs

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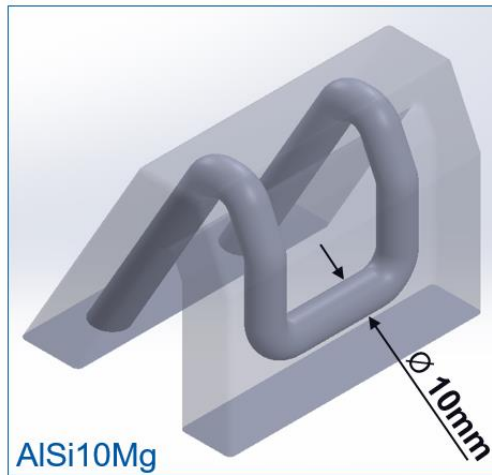
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M3DP Manufacturing Restrictions

Thin Walls / Bores and Cylinders / Gaps

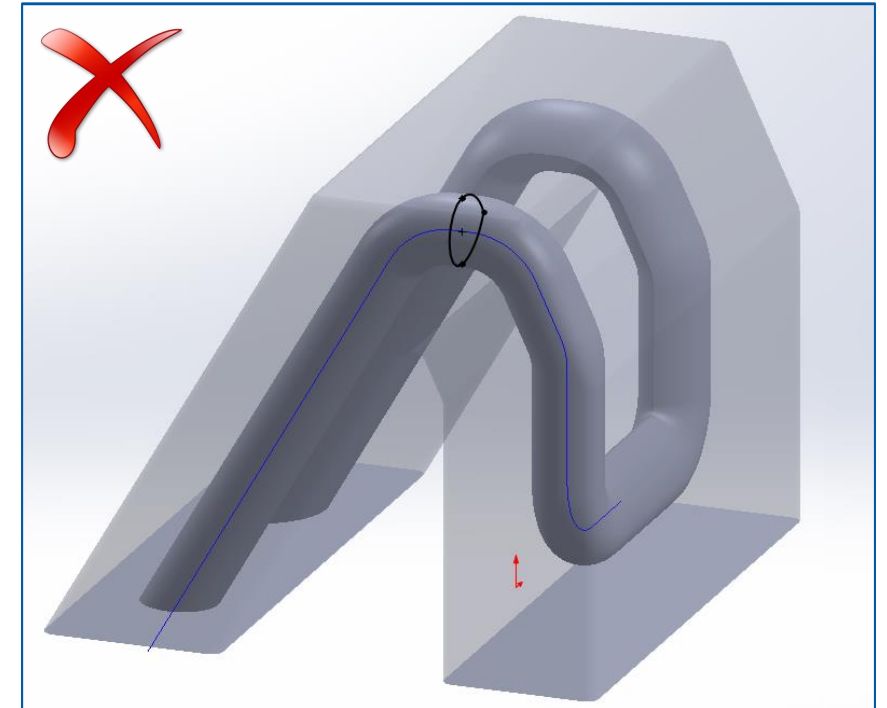
Internal channels



Redesign with Gothic Arc?



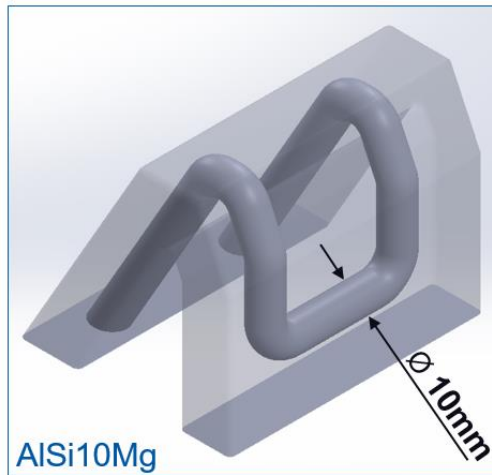
Not with a simple sweep



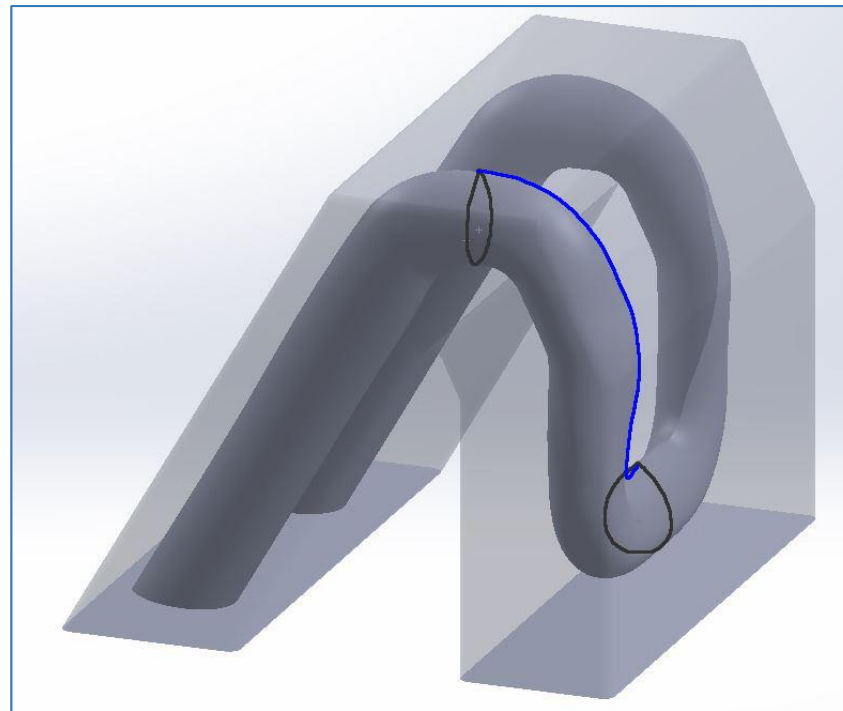
M3DP Manufacturing Restrictions

Thin Walls / Bores and Cylinders / Gaps

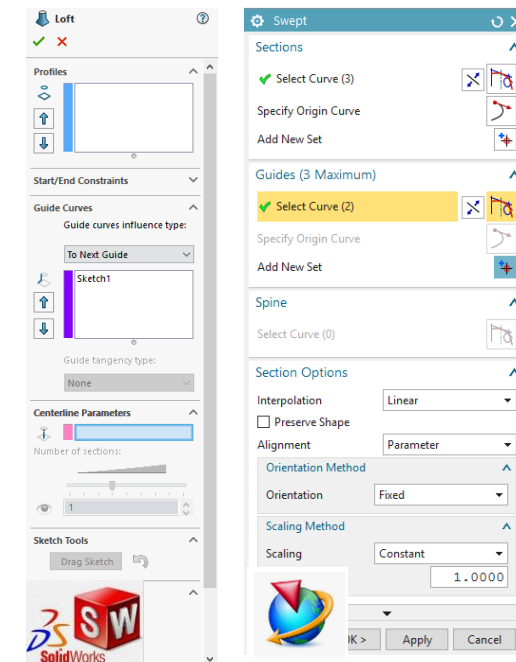
Internal channels



Redesign with twisted Gothic Arc



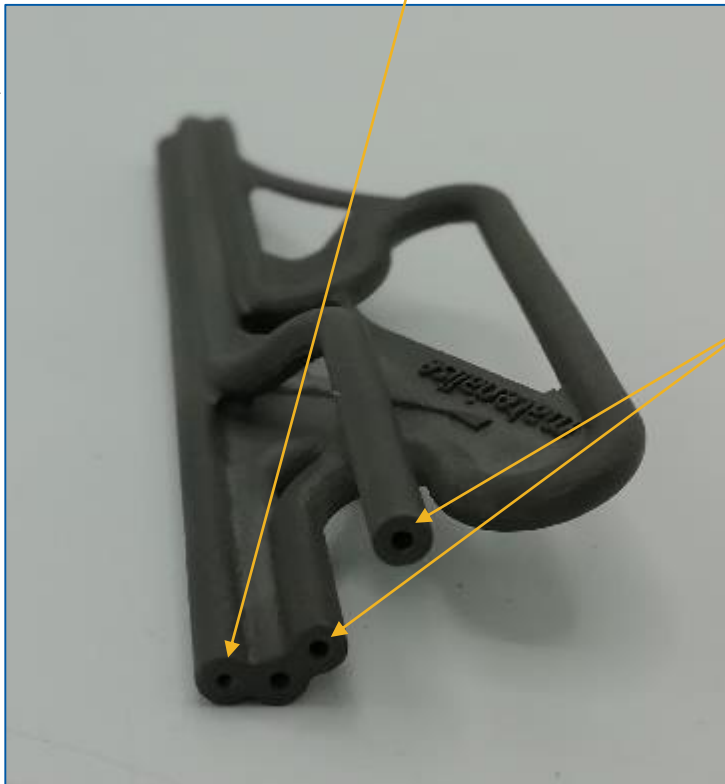
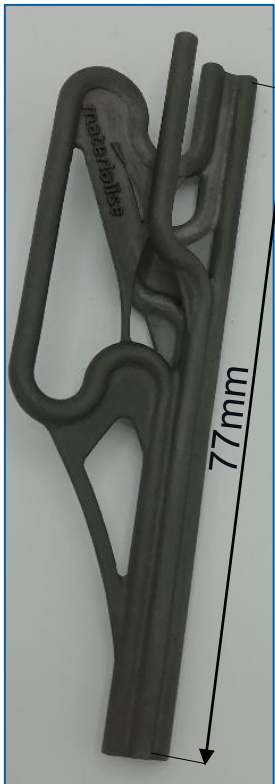
- Design centerline
- Use several cross sections
- Create Loft (Solidworks) / Swept (Siemens NX) between cross sections and use centerline



M3DP Manufacturing Restrictions

Thin Walls / Bores and Cylinders / Gaps

Internal channels



Ø0,5mm

Ø0,8mm

Sample: Ti6Al4V

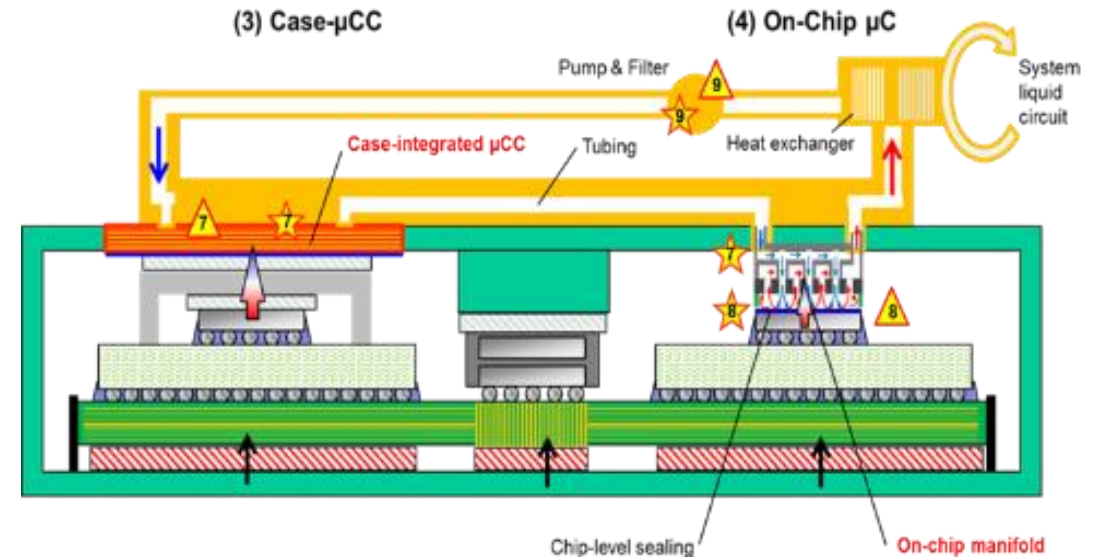
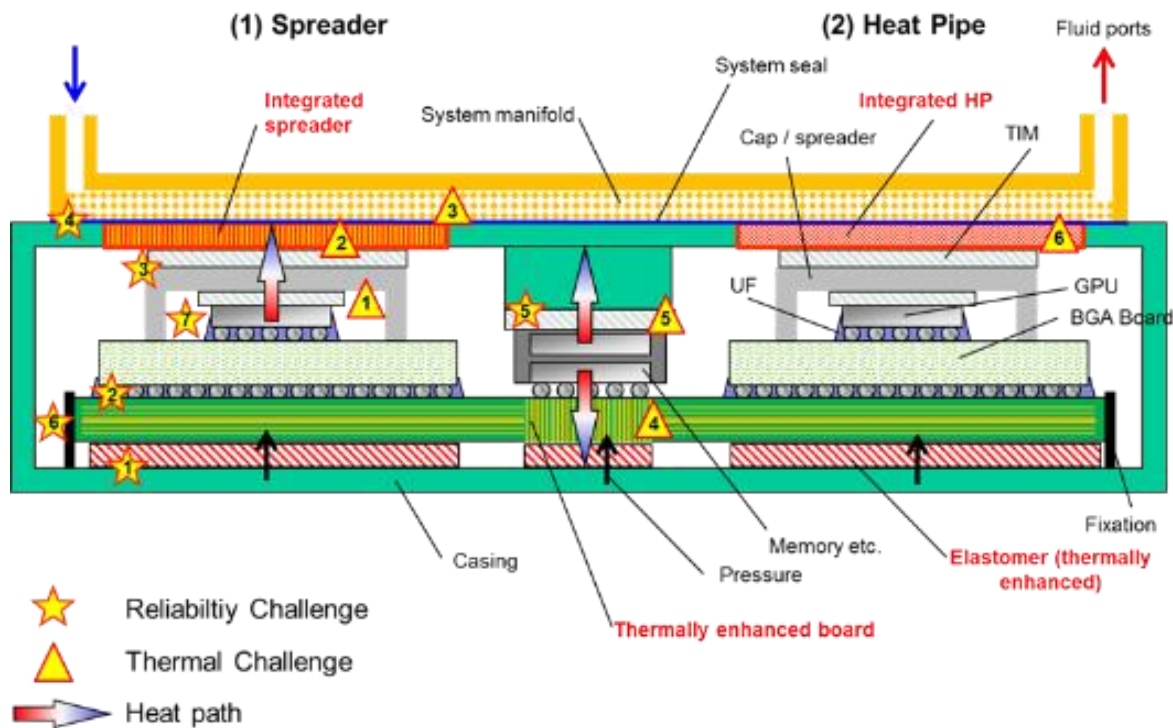


X-Ray Scan

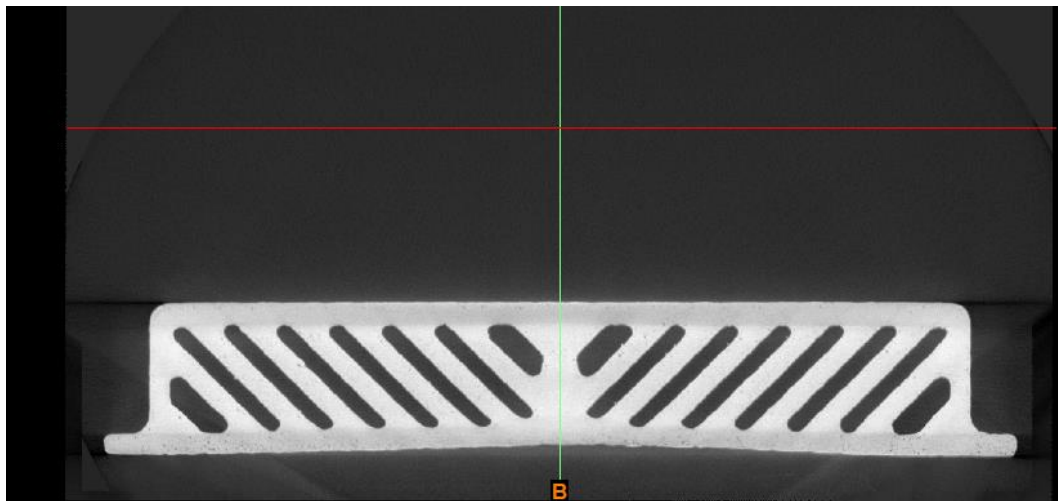
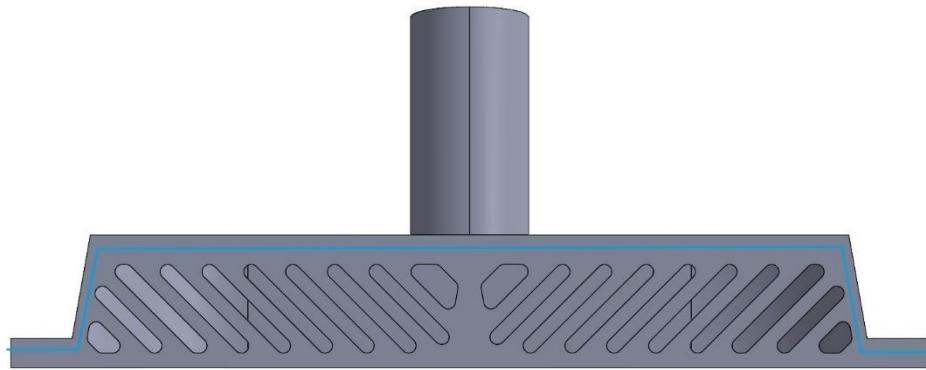


5. Heatsink designs

AM Heatsink designs

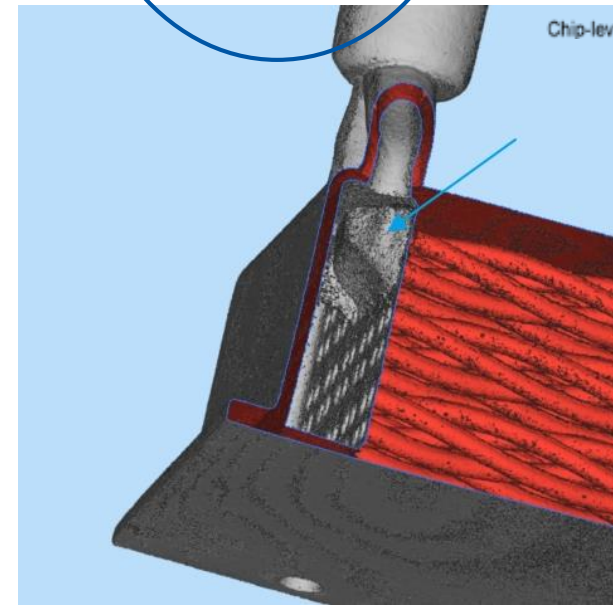
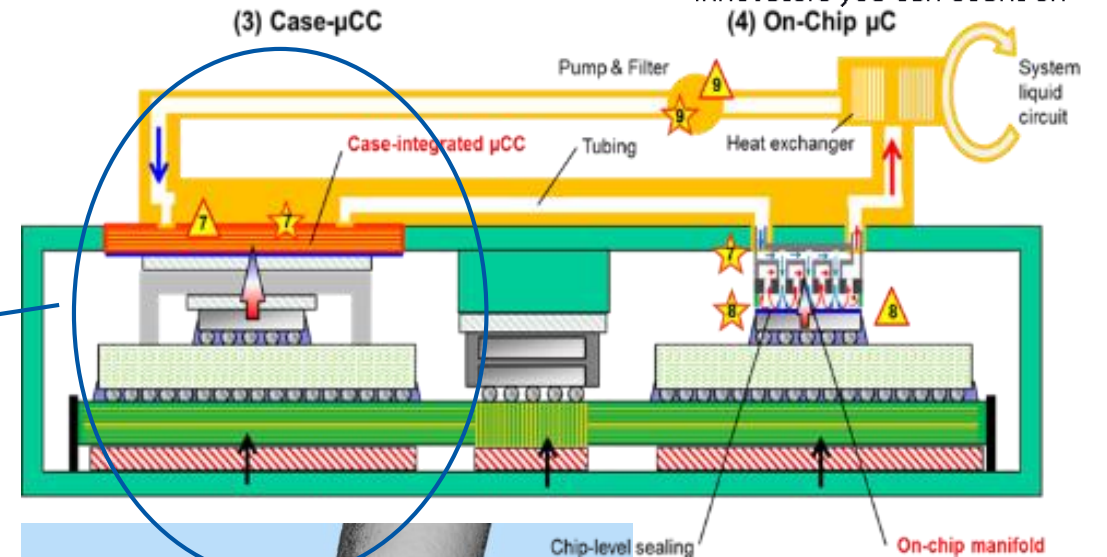


3) In case micro cooling channels

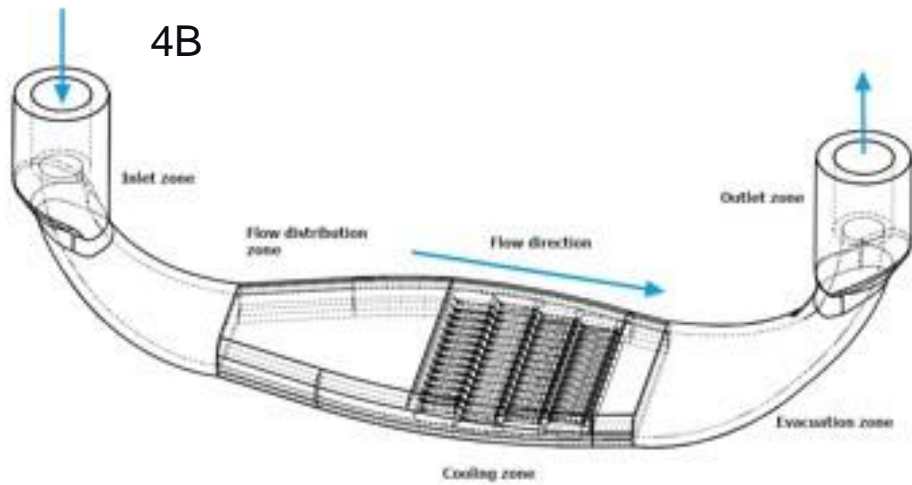


materialise

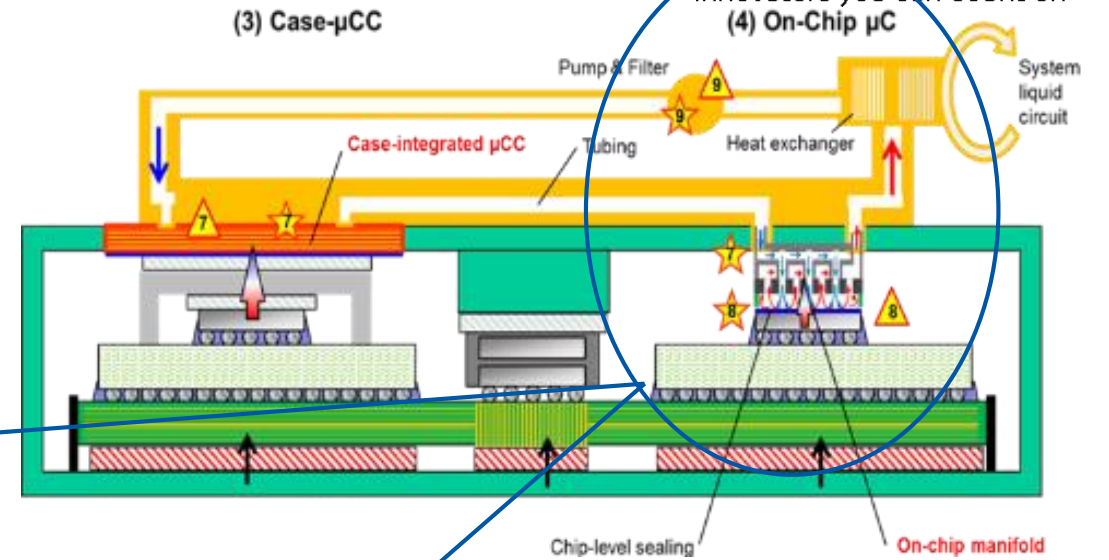
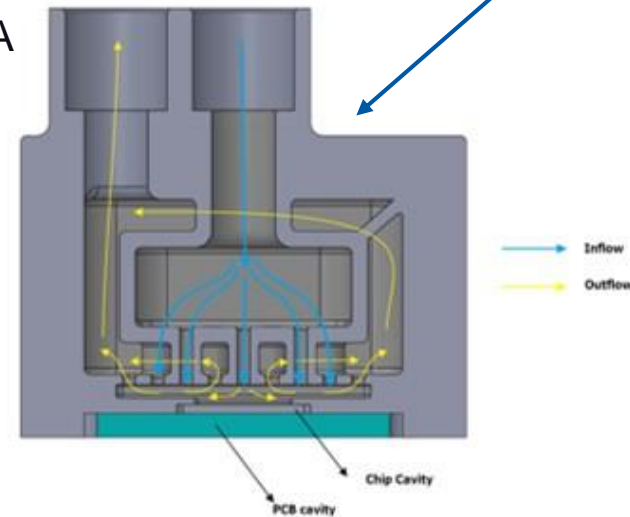
innovators you can count on



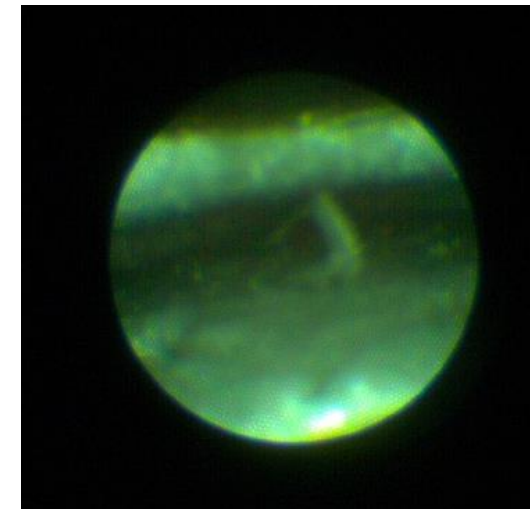
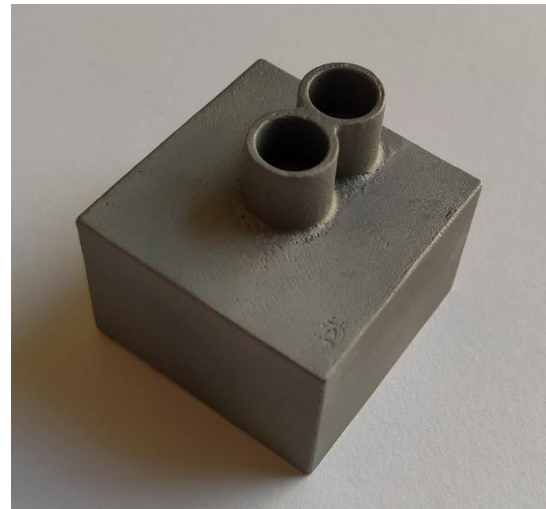
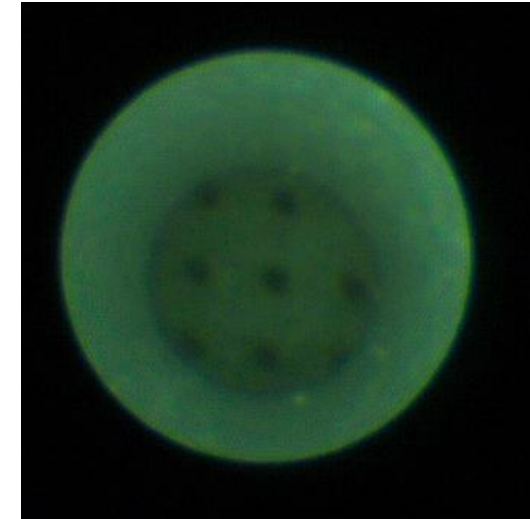
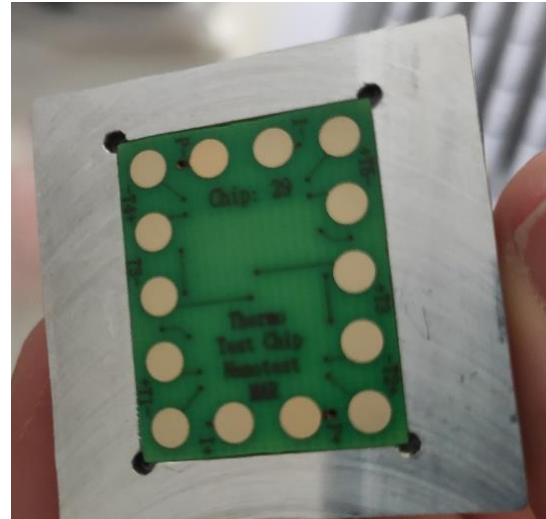
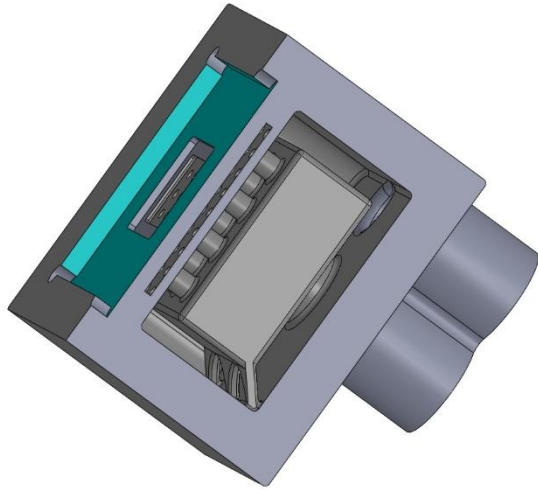
4) On-chip micro cooling channels



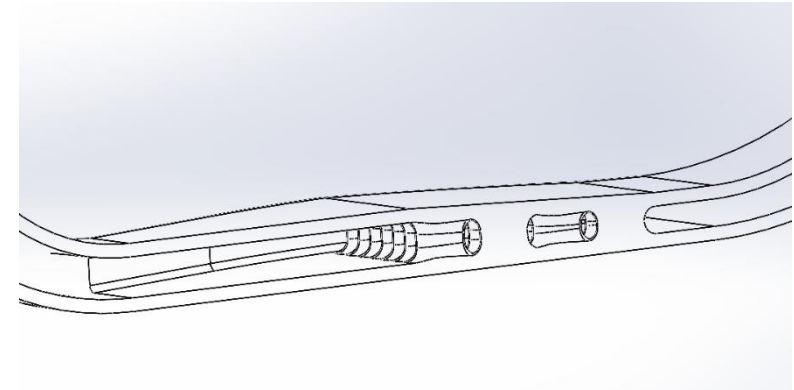
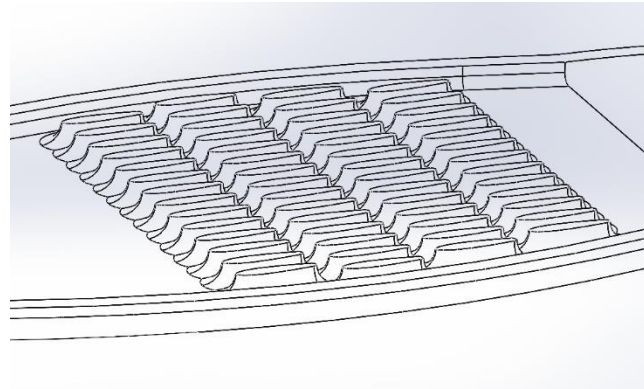
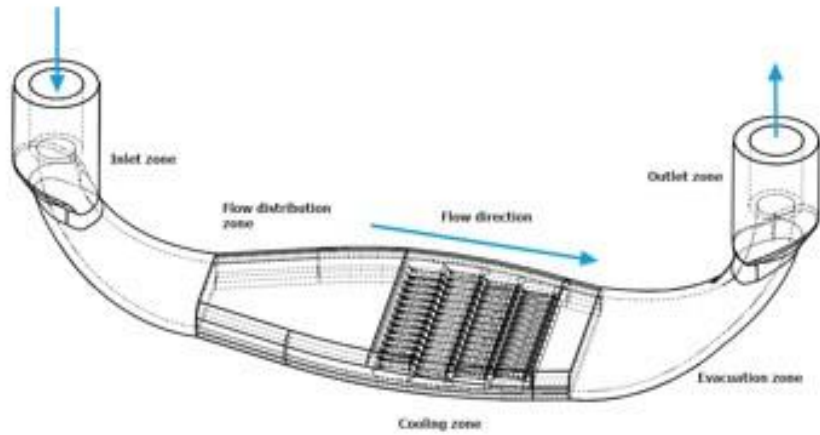
4A



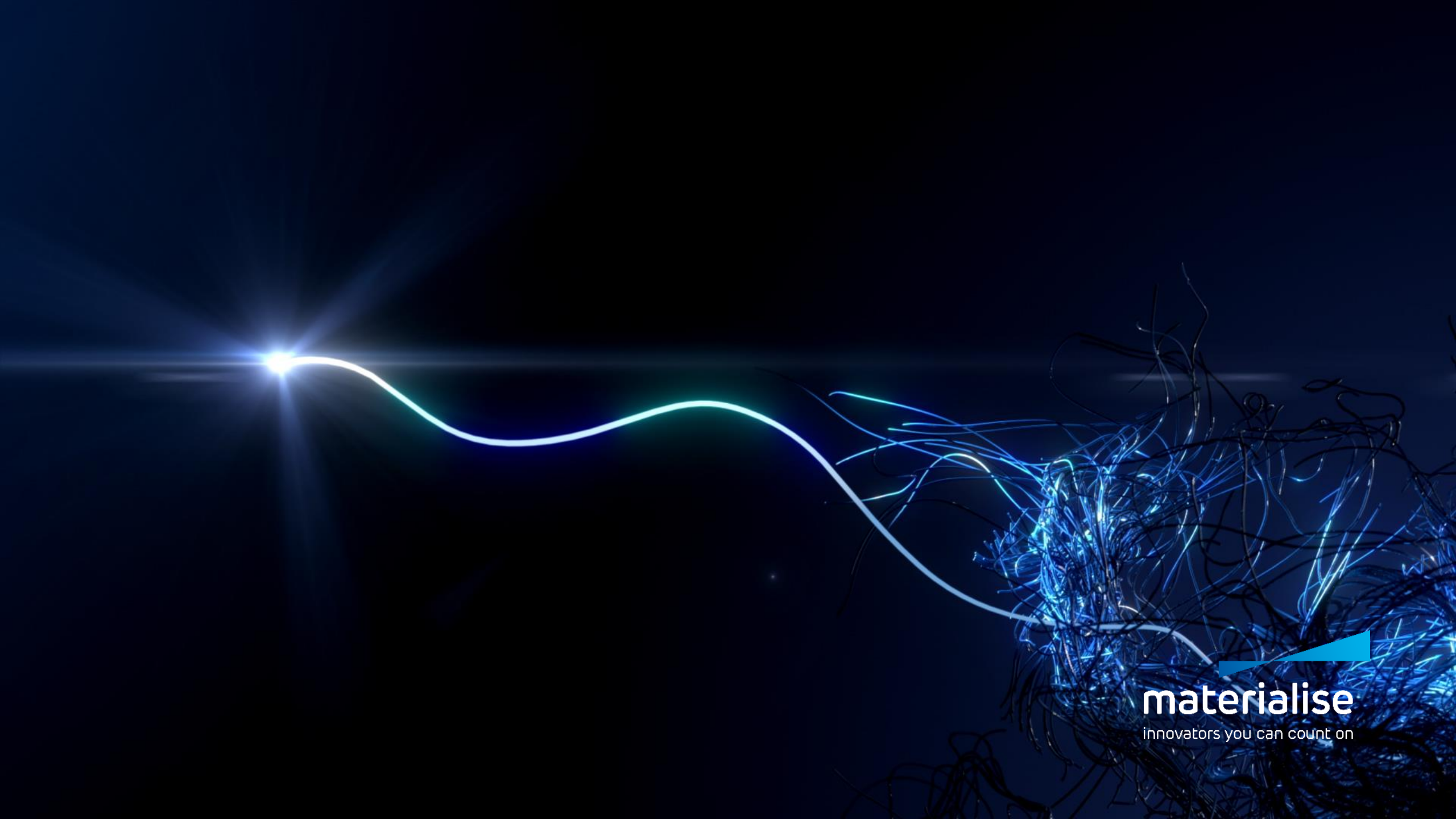
4A) Jet impingement design IMEC



4B) On chip closed chamber



6. Questions



materialise

innovators you can count on